

C) Remarks:

The amendments to the specification on pages 23, 27 and 30 are merely explanations respectively as to what is already shown on the associated tables 2, 3 and 4, and therefore this is not considered to be new subject matter.

According to the Office Action, claims 10-12 are rejected under 35 U.S.C. 102(b) and claims 13-21 are rejected under 35 U.S.C.103(a) as being unpatentable over alone Japanese Publication 11-106770 (JP'770) or in view of Mandelik (3,771,261) and other references.

However, in view of the foregoing amendments and the following remarks, reconsideration is respectfully requested. Claims 10-21 should be allowed because claim 10 of this invention is quite different from JP'770.

The following is the comparison between this invention and JP'770.

This invention relates to a method for producing safe town gas containing mainly methane by using dimethyl ether as feed stock. The gas produced by this invention has high calorie content and is safe because the gas hardly includes carbon monoxide.

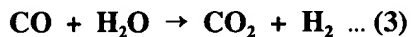
In a method for producing town gas according to claim 10, the steps comprise the step of preparing dimethyl ether as feed stock, the step of evaporating the dimethyl ether, and the step of

exothermically reforming the dimethyl ether in the presence of catalyst and steam to produce reformed gas containing mainly methane of which a yield (except H₂O) at outlet of the final reforming reactor is at least 50.6mol% and containing CO of which a yield (except H₂O) at outlet of the final reforming reactor is less than 1.8mol%.

Such a method for producing town gas is carried out according to the following reaction equation (1), theoretically (Table 1):



In practice, hydrogen (H₂) and carbon monoxide (CO) are also produced besides methane (CH₄) and carbon dioxide (CO₂) produced with the reaction equation (1). Simultaneously, the following equations (2)~(4) proceed:



Accordingly, when dimethyl ether is reformed catalytically, the reformed gas contains H₂, CO, CO₂, H₂O, and mainly CH₄. Compositions of the reforming gas vary with the reaction temperature, kinds of catalysts and so on. The compositions of the reformed gas, are about 50~70% CH₄, 20~25% CO₂, 10~30% H₂ and 0~3% CO, besides H₂O (lines 12 to 16 of page 7 of the original specification of this invention).

Examples 1~3 of this invention disclose concentrations (yields) of CH₄ and CO in the reaction product (except H₂O) at the outlet of the reforming reactor. The yields are 50.6mol% CH₄ and 1.8mol% CO in Example 1 (Table 2 [1k]). As shown in Table 2 [1k], the outlet gas of second

reforming reactor contains 27.5mol% CH₄, 1.0mol% CO and 45.7mol% H₂O. Excluding H₂O, the yields of CH₄ and CO are as following:

$$\text{CH}_4: \{27.5/(100-45.7)\} \times 100 = 50.6[\text{mol}\%]$$

$$\text{CO} : \{1.0/(100-45.7)\} \times 100 = 1.8[\text{mol}\%]$$

Further, the yields are 73.8mol% CH₄ and 0.0mol% CO in Example 2 (Table 3 [2d]). As shown in Table 3 [2d], the outlet gas of reforming reactor contains 49.6mol% CH₄, 0.0mol% CO and 32.8mol% H₂O. Excluding H₂O, the yields of CH₄ and CO are as following:

$$\text{CH}_4: \{49.6/(100-32.8)\} \times 100 = 73.8[\text{mol}\%]$$

$$\text{CO} : \{0.0/(100-32.8)\} \times 100 = 0.0[\text{mol}\%]$$

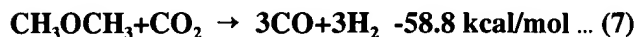
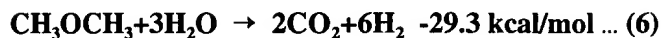
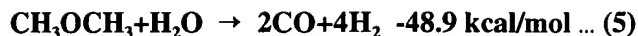
Furthermore, the yields are 71.9mol% CH₄ and 0.0mol% CO in Example 3 (Table 4 [3h]). As shown in Table 4 [3h], the outlet gas of reforming reactor contains 42.0mol% CH₄, 0.0mol% CO and 41.6mol% H₂O. Excluding H₂O, the yields of CH₄ and CO are as following:

$$\text{CH}_4: \{42.0/(100-41.6)\} \times 100 = 71.9[\text{mol}\%]$$

$$\text{CO} : \{0.0/(100-41.6)\} \times 100 = 0.0[\text{mol}\%]$$

As described, high safety town gas can be produced by this invention because the concentration of CO is very low.

On the other hand, JP'770 relates to a method for producing synthetic gas or hydrogen gas by reforming dimethyl ether. The synthetic gas is the mixed gas of carbon monoxide (CO) and hydrogen (H₂). The reforming reaction of dimethyl ether is shown in the following equations (5)~(7) (Section [0012]):



The synthetic gas produced of these reaction equations (5)~(7) has low calorie content and includes a large quantity of CO that is harmful. Accordingly, the synthetic gas is improper to use as town gas in view of safety consideration.

For example, the concentrations (yields) of CO in the reformed gas produced using catalyst examples 2, 5 and 27 of JP'770 are 39.6%, 34.6% and 52.2%, respectively. These concentrations of CO are very high.

Further, the concentrations of hydrocarbon (such as methane) in the reformed gas produced using catalyst examples 2, 5 and 27 of JP'770 are 2.2%, 0.3% and 15.9%, respectively. These concentrations are much lower than the concentration of methane in the reformed gas produced by this invention.

As described, this invention and JP'770 are similar to each other in using dimethyl ether as feed stock. However, this invention and JP'770 are different from each other in the concentrations (yields) of CH₄ and CO in the produced gas.

The reforming reaction of dimethyl ether concerning this invention is the reaction which does not consume water (H₂O). The reforming reaction shown in the above equation (1) is highly exothermic. Hence, when the temperature of the reaction system rises excessively, the reforming

reaction will increase the amount of byproduced CO due to chemical equilibrium, so that deactivation of the catalyst will be promoted. In this invention, steam coexists for reforming reaction of dimethyl ether. The principal purpose of coexistence of steam is to suppress the temperature rise of the reaction system.

On the other hand, the reforming reaction of JP'770 is the reaction which consume much water. Accordingly, this reaction system needs supply of much water from outside. JP'770 discloses that the quantity of the steam to be supplied is 1 to 20 mol times the quantity of the dimethyl ether in order to obtain a high dimethyl ether conversion ratio (Section [0027]).

As described, this invention and JP'770 are different from each other also in the operation of steam.

The Examiner also points out in the Office communication that JP'770 discloses methane as one of the reforming products with reaction temperature of 200~500℃. However, it is the methane which is a higher undesirable byproduct. Concerning JP'770, methane is neither an object nor a main component. Referring to the data of catalyst examples of JP'770, the highest yield of hydrocarbon is 15.9% (example 27). In other examples, the yields are less than 10%.

On the other hand, this invention is a method for producing the gas containing mainly methane which is a kind of hydrocarbon. The yield of methane in the reformed gas is at least 50.6mol% in this invention.

The reforming temperatures are overlapped between this invention and JP'770. However, the DME reforming reaction of JP'770 is an endothermic reaction and the heat necessary for the reaction is obtained by heat exchange with exhaust gas (Section [0092], Fig1).

On the other hand, the DME reforming reaction is an exothermic reaction in this invention. When dimethyl ether is supplied with temperature of 300℃ at the inlet of reforming reactor, the temperature of the exit gas of catalyst layer of the reactor rises to 545℃ (Table 2, lines 3 to 5 of page 23 of the original specification of this invention). In this invention, the reforming temperature is controlled by the quantity of coexisting steam. Such operation of the steam is not disclosed in JP'770.

As above described, this invention and JP'770 are quite different from each other in these objects and functions, operations or effects. Accordingly, claims 10-12 of this invention should not be rejected based on JP'770 under 35 U.S.C. 102(b).

Further, the claims 13-21 of this invention depend on claim 10 of this invention. Claim 10 is quite different from JP'770 as above mentioned. Accordingly, claims 13-21 also should not be rejected based on the combination of JP'770 and other prior art cited under 35 U.S.C. 103(a).

In view of the foregoing amendments and remarks, it is now believed that this application is in condition for allowance. Accordingly, favorable reconsideration with notice of allowance is requested.

Respectfully submitted,

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